A START TOWARD MICRONUCLEUS-BASED DECOMPRESSION MODELS; ALTITUDE DECOMPRESSION

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INTRODUCTION: Do gaseous micronuclei trigger the formation of bubbles in decompression sickness (DCS)? Most previous instructions for DCS prevention have been oriented toward supersaturated gas in tissue. We are developing a mathematical model that is oriented toward the expected behavior of micronuclei. The issue is simplified in altitude decompressions because the aviator or astronaut is exposed only to decompression, whereas in diving there is a compression before the decompression.

METHODS: The model deals with four variables: duration of breathing of 100% oxygen before going to altitude (O_2 prebreathing), altitude of the exposure, exposure duration, and rate of ascent. Assumptions: a) there is a population of micronuclei of various sizes having a range of characteristics, b) micronuclei are stable until they grow to a certain "critical nucleation radius," c) it takes time for gas to diffuse in or out of micronuclei, and d) all other variables being equal, growth of micronuclei upon decompression is more rapid at high altitude because of the rarified gas in the micronuclei. To estimate parameters, we use a dataset of 4,756 men in altitude chambers exposed to various combinations of the model's variables.

RESULTS: The model predicts occurrence of DCS symptoms quite well. It is notable that both the altitude chamber data and the model show little effect of O_2 prebreathing until it lasts more than 60 minutes; this is in contrast to a conventional idea that the benefit of prebreathing is directly due to exponential washout of tissue nitrogen.

CONCLUSION: The delay in response to O_2 prebreathing can be interpreted as time required for outward diffusion of nitrogen; when the micronuclei become small enough, they are disabled, either by "crushing" or because they cannot expand to a critical nucleation size when the subject ascends to altitude.